

Accessory Dwelling Units:

Sustainable Housing for the Bay Area

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Introduction | Zoning and Permitting | Construction Alternatives | Energy Efficiency | Next Steps

WHAT IS AN ADU??!

Presentation Outline

- Problem Statement
 - **Why** are ADUs the **best solution** to the problem?
 - Goals and Project Deliverables
 - **What** are the **permitting barriers** associated with ADUs?
 - **What** are the different ADU **construction options**?
 - **How** can we optimize ADU **energy efficiency**?
 - **How** can future work be **continued sustainably**?



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For most of our presentation, we're going to take you through the process as if you were a homeowner building an ADU. However, our mentors are mainly concerned with the design and financing side, so we're not going to talk about that as much.

Problem:



By the year 2035, the Bay Area's population is expected to grow by **2 million people**, requiring **700,000 new housing units**.



If current trends continue, most of this housing will be located in the suburbs, because that's where housing is most affordable.

Environmental Impact - Infill vs Sprawl

	Sprawl	Transit Village	Urban Center
	San Ramon, CA	Rockridge, Oakland, CA	North Beach, San Francisco
Res Density (hh/res. Acre)	3.2	10	100
Transit (veh/hr nearby)	1	27	90
Shopping (5 w/in ¼ mi)	No homes	25% of homes	All homes
Pedestrian Amenities	Low	Medium	High
Autos/capita	0.79	0.66	0.28
Auto miles/capita	10,591	6,455	2,759
Ann. Auto cost/capita	\$8,200	\$5,030	\$1,900
Ann. lbs CO2 emissions/capita	14,827	9037	3863
Housing sales prices	\$295/ft ²	\$407/ft ²	\$1,858/ft ²

Holtzclaw, Using Residential Patterns and Transit to Decrease Auto Dependence and Costs www.sflcv.org/density

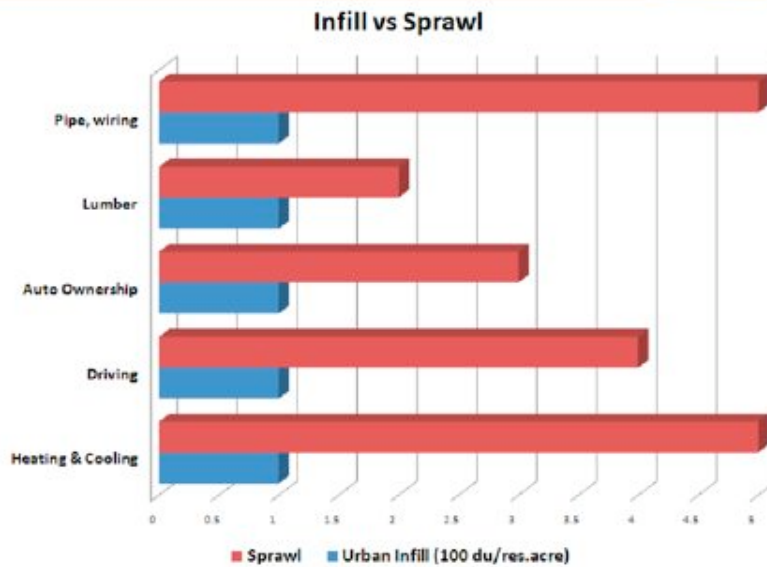
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We found data for different neighborhood types in the bay area. This chart shows the clear relationship between density and environmental impact through car usage. It also contains other information, showing that denser neighborhoods also have more transit options, shopping and pedestrian amenities, and other things associated with a more liveable neighborhood. But we wanted to focus here on the large impact that infill can have on reducing CO2 emissions.

This is to say that when someone decides to move into the Bay the Area, the choice of where they live has significant environmental and social consequences, because with this choice comes an entire life-style. From this chart the impact of this life-style ranges by a factor of 4.

This chart also illustrates the type of neighborhood we are trying to target and why:

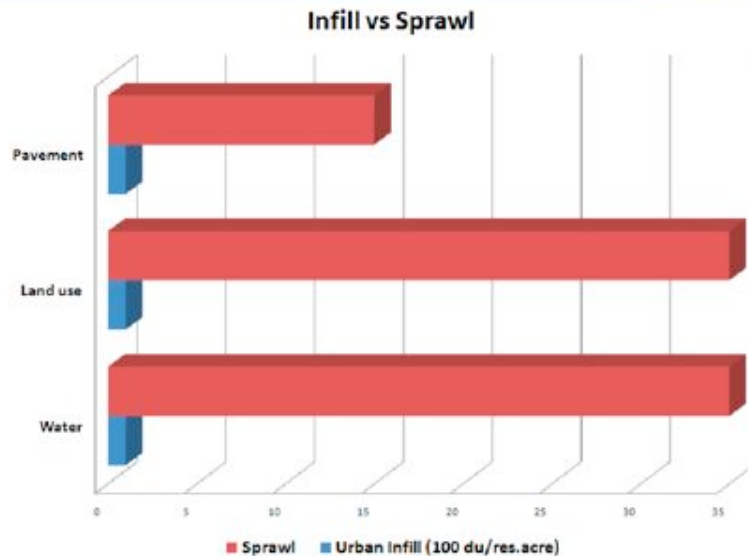
- The sprawling neighborhoods like San Ramon, don't have the critical mass or infrastructure to be conducive to additional housing.
- Urban centers are like San Francisco are already saturated
- So we will focus on these "transit villages", like Rockridge, West Berkeley. These are neighborhoods that have existing infrastructure to handle additional people, but still have quite low density.



Holtzclaw, *How Does Smart Growth Impact Climate Change Emissions?* 2007

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We also wanted to point out that in choosing infill rather than building out, reduced CO2 emissions from reduced driving is not the only benefit. The use of utility infrastructure, lumber and heating is also greatly reduced through infill.



Holtzclaw, *How Does Smart Growth Impact Climate Change Emissions?* 2007

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The impact on pavement, land and water usage is even greater.

In these two graphs, everything has been benchmarked to urban infill i.e. for every meter of pavement used in infill housing, 15 is used for sprawl. For every liter of water used for infill, 35 is used for sprawl. It should be noted that these infill values are for high density infill (100du/res. Acre). We are working in the areas of around 20 units /res.acre, but the trends are the same.

Multiple Benefits...

Housing Benefits

- Meets needs of changing demographic trends i.e. smaller households, elderly, singles, empty nesters
- Affordable housing (smaller, increased supply)
- Additional income from rents



Environmental Benefits

- Decreases negative impacts of urban sprawl
- Increased density results in less auto-dependency
- Reduces demand to develop virgin land
- Energy efficient homes
- Uses existing infrastructure



Other Benefits:

- Strengthens existing neighborhoods
- Lower cost on cities, and increased tax revenues



Goal: Provide fiscally and environmentally responsible housing solution recommendations

Project Deliverables:

Environmental assessment of various ADU options

ADU Permitting Handbook

Sustainable business model recommendation

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The goal of this project

Short-term goals (1year): Build a couple homes as proof of concept, partnering with Cal-Cottages or Backyard Homes



Cal-Cottages:

Foundations:

~ 2.5 weeks

House:

Set House

~ 3 hours

Roofing + stucco,
hardwood flooring

~ 4 days

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Zoning and permitting is the **single largest barrier** for homeowners who wish to install ADUs on their property.

"When I realized that the city was going to require me to put in another parking space, I decided to build [my ADU] illegally."
—Oakland ADU builder

"None of our neighbors had a problem with us building it, but it still took a year to get the permits from the city."
—Berkeley ADU owner

"If the city wants more of these units going in, it may have to ease the setback requirements."
—Berkeley architect and ADU owner

"The extra parking space is the main challenge."
—Berkeley planner

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We interviewed 4 Berkeley planning staff, 2 developers, and 10 ADU dwellers/owners about the process of building an ADU. This was not comprehensive market research, nor did we feel that it needed to be, because all of our interviewees said the same thing.

If your ADU does not conform to rigorous requirements for:

- Setbacks
- Lot size and coverage
- Floor area
- Parking

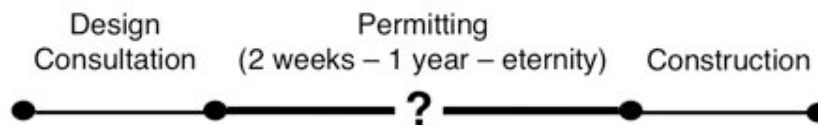
...you may have to pay more money for permits, re-draft plans at the behest of the city, settle disputes with neighbors before the zoning board, etc.



It's important to recognize that zoning laws are not the result of evil city officials or collusion between the City of Berkeley and big oil—they're over-protective and inflexible because they're the cumulative result of thousands of complaints by homeowners. *These very homeowners are our target market.* These requirements combine to make it difficult to build on small Berkeley lots, where there may not be much space for a legal ADU or a parking space. We researched four other Bay Area communities and found that lots are larger, but ADU requirements are often more strict.

The permitting process creates uncertainty right in the middle of our involvement with our clients, making it difficult for our business to develop a streamlined, efficient model. It also intimidates potential clients.

On one hand, assisting clients with permitting may increase our base substantially. On the other hand, it may be prohibitively expensive.



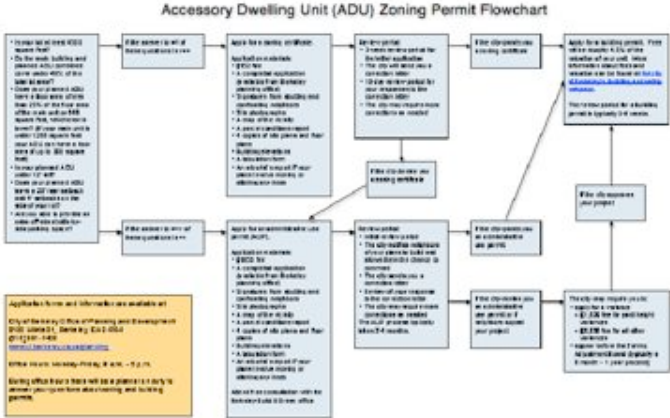
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All of the homeowners that we interviewed who had successfully installed an ADU were architects or contractors.

The process also prevents challenges to scaling the business up, because each city has different zoning codes.

Developers can employ someone to spend 6 mos.-1 yr. defending a 500-unit development with a large profit margin, but the battle may be just as long with much less payoff for an ADU.

If we can't hold everyone's hand, at least we can provide outreach and educational materials that will make permitting easier.



The flowchart shows just what a complex process this is. This should be easy information to get, but it's not. I had to compile it together from the city's zoning code and several different documents from the Berkeley planning office, as well as interviews with planners.

We are also using GIS and census data to identify neighborhoods that are rich with opportunities for ADU construction.



We are recommending targeted measures to mitigate zoning requirements in these areas:

- Proximity to transit
- Programmatic parking studies
- Car sharing

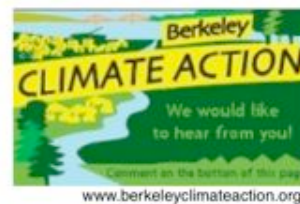
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Lots with space for an ADU are in green, lots without space are orange, and lots that already have ADUs on them are blue. The blue-shaded circles represent quarter- and half-mile walks from the North Berkeley BART station.

We've been lobbying Berkeley city staff to include ADUs in city projects and policy initiatives.

East Bay Green Corridor: A partnership between the mayors of Berkeley, Albany, Emeryville, and Oakland to "promote the East Bay as the nucleus of a 'green wave' of research and manufacturing." Currently no plans for housing these new workers.

Berkeley Climate Action Plan: Approved for environmental review on May 5th, 2009. A guiding policy document calling for higher densities in neighborhoods served by transit that does not specifically mention ADUs.



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Even if we were successful, it would take a year or two for us to actually change the zoning code, and the changes would only apply to one city, or even one neighborhood. But it would be a crucial long-term success.

Our criteria for assessing construction alternatives are:

- **Initial cost** (cost/ft²)
- **Sizes available** (ft²)
- **Ease of construction** (includes time on-site and off-site and lead time from initial customer order)
- **Level of customization**

Image sources:
<http://citesix.com/newsfeed/wp-content/uploads/2008/12/livinghomes.jpg>
<http://www.palmharbor.com/resource/palmharbor/SiteObjects/published/>
<http://www.mkd-arc.com/homes/mklotus/images/tour/07.jpg>



Alternatives Assessment

	Cost	Size (ft ²)	Cost/ft ²	Construction	Customization
Valley Home Designs					
Living Homes					
Michelle Kaufman	+	500	\$250.00	+	-
Cal Cottages	+	700	\$161.43	+	-
Backyard Cottages	++	627	\$133.97	+	-
Zamore	-	400	\$145.00	-	++
Flat Pack House					
Parco Homes					

- Costs are based on multiple models, and how inclusive costs are: transportation, design...
- Permitting costs not included

CO₂ equivalent (kg CO₂/ft²*yr)

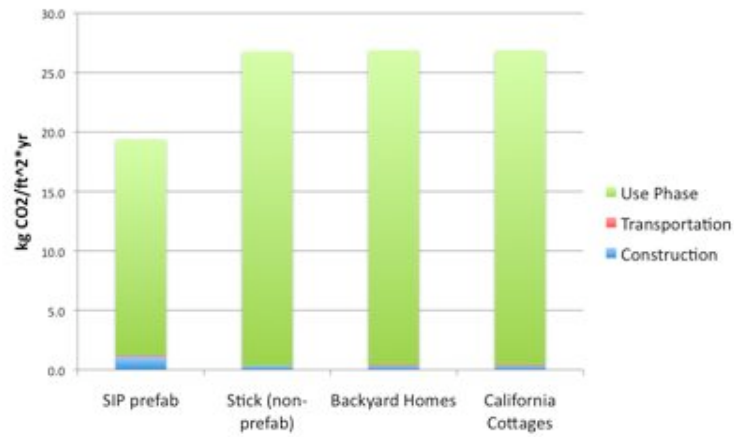
	SIP prefab	Stick (non-prefab)	Backyard Homes	California Cottages
Construction	1.1	0.3	0.3	0.3
Transportation	0.1	0.0	0.1	0.1
Use Phase	18.2	26.5	26.5	26.5
Total	19.4	26.8	26.9	26.9

Energy use (kWh/ft²*yr)

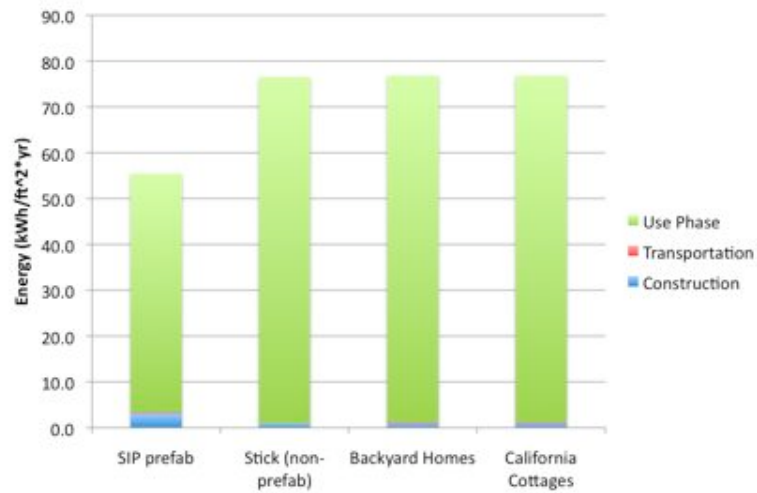
	SIP prefab	Stick (non-prefab)	Backyard Homes	California Cottages
Construction	3.1	1.0	1.0	1.0
Transportation	0.3	0.0	0.3	0.3
Use Phase	52.0	75.6	75.6	75.6
Total	55.4	76.5	76.8	76.8

Source: CO₂ to kWh conversion factor: EIA 2007, http://www.eia.doe.gov/oiat/1605/pdf/Appendix%20F_r071023.pdf
Bourne S, Liu S, Santiago A L, 2008.

CO₂ equiv. (kg CO₂/ft²*yr)

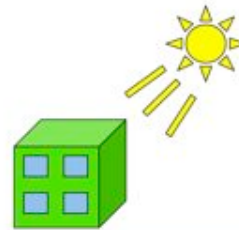


Energy (kWh/ft²*yr)



Use Phase Burden Reduction

- Why promote energy efficiency?
 - Benefits for owners:
 - Must prove cost savings
 - Return on initial investment
 - Lease options for landlords seeking energy efficiency
 - Tax rebates and gov't subsidies
 - Promote sustainable growth
 - Diffusion of technologies
 - Business environmental stewardship



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Promoting sustainable growth: allowing for the diffusion of technologies within the Berkeley community

Design for Efficiency

Appliance Options:

Refrigerator

	Initial cost	Bill cost/month
EnergySTAR	\$1,100	\$43
Conventional	\$1,070	\$51
Savings	-\$30	+\$8

Dishwasher

	Initial cost	Bill cost/year
EnergySTAR	\$545	\$30
Conventional	\$545	\$54
difference	\$0	+\$24

Sustainability Facts	
Area: 2600 ft ²	Orientation: N/S axis
E Consumption	37,472 [*] Kbtu per year
CO2 Emission	16,292 lbs per year
Insulation	
Wall Assembly	22.1 R-value
Roof	38 R-value
Floor	33 R-value
Windows	
high performance dual-pane with low-e 0.28 U-Value	
[*] Provided Kbtu/yr based on total energy usage for heating, cooling, etc.	



Sources: Michelle Kaufmann's Blog, <http://blog.michellekaufmann.com/?p=529>
 ENERGY STAR, "Features of ENERGY STAR New Qualified Homes," 2009, http://www.energystar.gov/index.cfm?c=new_homes.nh_feat
 ENERGY STAR, "Dishwasher Savings Calculator," 2009, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerDishwasher.xls
 ENERGY STAR, "Refrigerator Savings Calculator," 2009, http://www.energystar.gov/ia/business/bulk_purchasing/bpsavings_calc/CalculatorConsumerResidentialRefrigerator.xls

Energy Efficient
Technology Screening
Process

Energy Efficient Technology



USER NEEDS ASSESSMENT

- Affordability
- Scalability
- Low maintenance
- Constructability

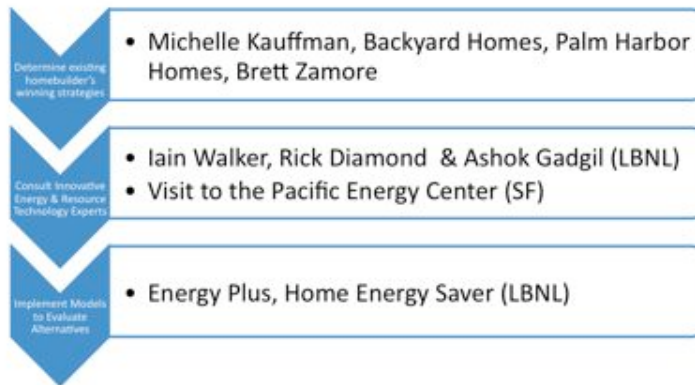


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We may want to address Johanna's question about why energy efficiency is important here. - ER

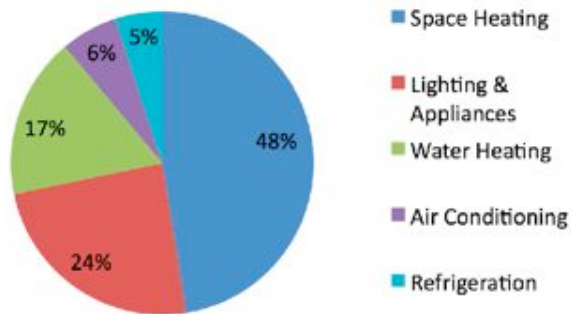
Energy Efficient Technology Screening Process

Idea Sourcing



Energy Efficient Technology Screening Process

Home Energy Use (Ave.)



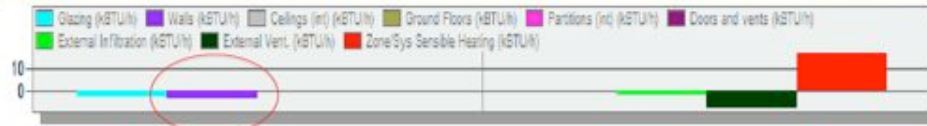
Data Source: <http://www.eia.doe.gov/kids/energyfacts/uses/residence.html>



Energy Plus Model Output for Test Case

Sample Design Variable: Insulated Exterior Walls

Pictures/Data Source: DesignBuilder and Energy Plus Model



Uralita Thermalite, R-8.6
Heat Loss Through Exterior Walls = -2.75 kBTU/h



Expanded Polystyrene, R-30.4
Heat Loss Through Exterior Walls = -0.82 kBTU/h



Energy Plus Model Output for Test Case

Sample Design Variable: Insulated Exterior Walls

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Source: DesignBuilder

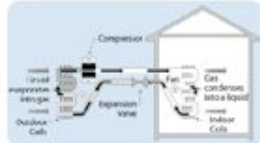
Energy Efficient Technology Screening Process

Building Envelope



http://www.efficientwindows.org/frames_cfm?id=3

Heating & Cooling



http://www.efficientwindows.org/frames_cfm?id=3

Efficient Appliances



http://www.efficientwindows.org/frames_cfm?id=3

Lighting & Orientation



www.lbl.gov

Current Business Model:



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The current model that our mentors provided us with was a for profit entity that simply dealt with the financing permitting, and construction of the ADU. However, during our research we discovered a few problems with the model. First, there was an incredibly negative perception of infill housing and urban densification. When you mentioned those terms, people immediately conjured images of high rises and Manhattan style living- both of which Berkeley residents are averse to. Also, there seemed to be a lack of knowledge about energy efficiency options. Most people agreed that energy efficiency was important, but didn't think that it was affordable. However, As mentioned before, with the new tax refunds and initiatives through local, state and federal governments, it is making energy efficiency a financially viable option. However, the public still doesn't seem to know.

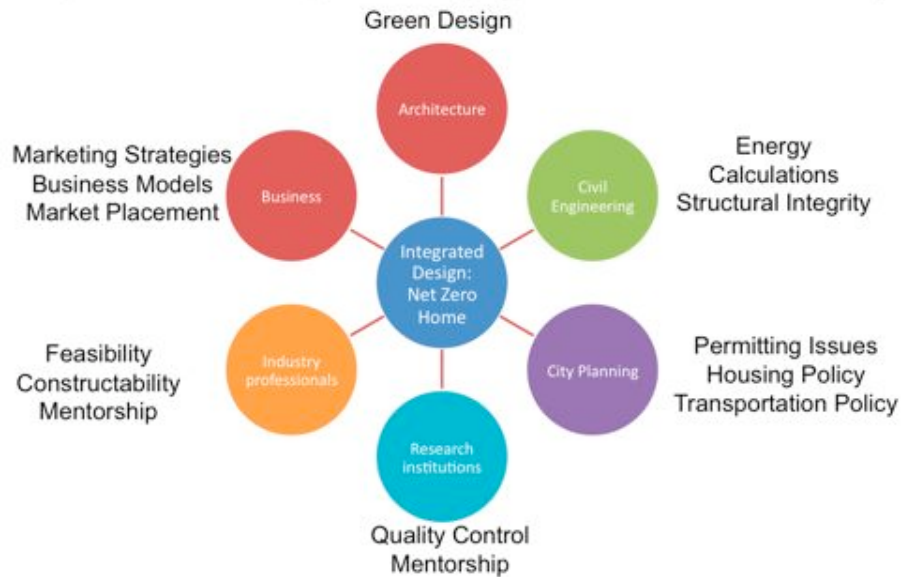
Benefits of Hybrid Business Model



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Our recommendation is to create a hybrid non profit, for profit business model. Like UV Waterworks, the non profit part of the business would deal with education. In UV Waterworks, people needed to understand why the water was contaminated, why clean water was important, and how to get access to affordable clean water. Taking that to the energy space, the non profit wing will educate the public on why there is an energy shortage, why that's important, and how they can take steps to be more energy efficient in an affordable way. The other part the non profit will address is the gap between academia and market. The best green design practices at the University level will be transferred to the for profit entity for mass commercialization.

Integrated Green Design: Leveraging Resources at UC Berkeley



The philosophy of the non profit is the same as CE 290- cross sector collaboration breeds innovation. By leveraging the multiple colleges in UC Berkeley and streamlining work in the energy space, the goal is to create net zero ADUs which are both affordable and aesthetically pleasing; ready for mass commercialization and mass market consumption.

Next Steps:

- Summer 2009: Build ADU for Karen Chapple
- Summer 2009: Obtain venture funding for business
- Summer 2009: Coordinate energy education efforts with local Berkeley organizations

Short-term goals (1year): Build a couple homes as proof of concept, partnering with Cal-Cottages or Backyard Homes



Cal-Cottages:

Foundations:

~ 2.5 weeks

House:

Set House

~ 3 hours

Roofing + stucco,
hardwood flooring

~ 4 days

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Awards

Bears Breaking Boundaries

- Social Innovation: Honorable Mention
- Improving Student Life: Honorable Mention

Clinton Global Initiative

- Finalist

Berkeley Business Plan Competition

- Semi-Finalist



Thank you!

Professor Ashok Gadgil
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Evan MacDonald
Jennifer Cogley

...and to our fellow CE290 students, especially those of you who presented last Wednesday. We stole a lot of your ideas.